DETAILS EXPLANATIONS

CE : Paper-2 (Paper-3) [Full Syllabus]

[PART : A]

1. Physical classification
(i) Stratified Rocks
(ii) Unstratified Rocks
(iii) Foliated Rocks

2. Lime is the important ingredient of cement, since it makes cement soundness and binding property.

3. For cube; strength = f_{ck}
For cylinder, strength = $0.8\ f_{ck}$
with increasing size; strength decreases.

4. This defect is caused because of alkali present in bricks when bricks comes in contact with water drying grey or white powder patches on the brick-surface.

5. TB = MB ± MD
TB = $30^\circ + 5^\circ = 35^\circ$
TB = N35°E

6. It is the hourly average of sea-levels taken for 19 years considering all the conditions of low and high tides.

7. (i) 1 cm = 30 m

$$RF = \frac{1}{3000}$$

(ii) 1 inch = 25 feet

$$RF = \frac{1}{25\times12} = \frac{1}{300}$$

8. Horizontal equivalent the horizontal distance between two consecutive contour-lines.

9. Multiplying constant $= \frac{f}{i} = \frac{24}{2.4\times10^{-1}} = \frac{24}{0.24} = 100$

10. (i) To provided superelevation from zero to the desigen value gradually so as to avoid discomfort to passangers.
(ii) To avoid the jerk

11. SO_2-effects on
(i) Paint → It causes decolouration and fading.
(ii) Metals → Causes corrosion, spoilage of surface loss of metal.

12. ***Total dissolved solids (TDS) :***

These are material remaining in the water after filteration. It can be measured by evaporating the waer which is filtered and remained material is weighted directly.

13. The infreastructure which includes device, equipments and appurtenances for the collection transportation and dumping.

14. The flow is calculated by measuring the speed at one or more points in the flow and integrating the flow speed over flow area.

15. Reynold's number is the ratio of inertia force and viscous force

$$R_e = \frac{F_i}{F_v} = \frac{\rho VD}{\mu}$$

16. The various elements included in the road margins are shoulder, parking lane, frontage road, driveway cycle track, footpath, guardrail and embankment slope.

17. Tar is the viscous material obtained when natural organic-materials such as wood and coal carbonized or destrictively distilled in the absence of air.

18. Rotary requires compartively a large area of land and; so where space is limited and costly as in builtup areas, the total cost may be very high.

19. The effluent from intermittant sand filter is of better quality, it is more clean and more stable, and hence doesn't need futher treatment before disposal.

20. Relative stability of sewage is defined as the ratio of available oxygen to the required oxygen satisfying first stage BOD.

[PART : B]

21. Total pressure is defined as the force exerted by a static fluid on a surface either plain or curved when the fluid comes in contact with the surfaces. Center of pressure is defined as the point of application of the total pressure on the surface.

22. Given, length of weir L = 20 m

Head over weir H = 1.0 m

$C_d = 0.62$

Using equation of discharge :

$$Q = \frac{2}{3} \times C_d L \sqrt{2g}.H^{3/2}$$

$$Q = \frac{2}{3} \times 0.62 \times 20 \sqrt{2 \times 9.81} \times (1)^{3/2} = 36.61 \text{ m}^3/\text{sec}$$

23. If the channel bottom is taken as bottom then the total energy per unit weight of liquid will be specific energy.

$$E = h + \frac{V^2}{2g}$$

Hence specific energy of a flowing liquid is defined as energy per unit weight of the liquid with respect to the bottom of the channel.

24. A manhole is a masonry of RCC chamber constructed on the alignment of a sewer for providing access to the sewer for the purposes of inspection, testing, cleaning and removal of obstructions from the sewer line.

The also help in joining sewer lines or in changing the direction or alignment or both. A manhole sometimes recieves the contribution of sewage.

25. Sewage flow

$$= 50000 \times 180 \times \frac{80}{100} \times 10^{-3}$$

$$= 7200 \text{ m}^3/\text{day}$$

$$\text{Capacity} = \frac{7200 \times 2}{24} = 600 \text{ m}^3$$

(for a detention period of 2 hours)

Again let us assume an over flow rate of 30 $m^3/day/m^2$ for average flow :

$$\text{Surface area} = \frac{7200}{30} = 240 \text{ m}^2$$

$$\therefore \text{ Effective depth} = \frac{600}{240} = 2.5 \text{ m}$$

For diameter, $\frac{\pi}{4}D^2 = 240$

$$D = \text{Diameter} \simeq 17.5\text{m}$$

26. $h = 20$ cm

$a = 15$

$$\frac{a}{h} = \frac{15}{20} = \frac{3}{4} = 0.75 < 1.724$$

Therefore, quivalent radius

$$b = \sqrt{1.6a^2 + h^2} - 0.675h$$

$$b = \left(\sqrt{1.6 \times 15^2 + 20^2}\right) - (0.675 \times 20)$$

$$b = 14.07 \text{ cm}$$

27. The important factors taken into account for a simple analysis of PCU values of different vehicle classes are :

(i) Average speed of the vehicle class under the prevailing roadway & traffic conditions within the desired speed range.

(ii) Average length and width of the vehicle class.

(iii) Average transverse gap and longitudinal gap allowed between the vehicles of the same calss.

28. *(i) Over Burning of Brick :*

Brick should be burned at temperature of which incipient complete and viscous vitrification occures. However, in the brick are over burnt a soft mass is produced & bricks loose their shape.

(ii) Under Burning of Brick

When bricks are not burnt to cause complete vitrification the insufficient heat causes pores opened resulting in high water absorption.

(iii) Efflorescence :

This defect is caused because of alkali present in bricks and it causes grey or white pathes over the brick surface.

29. ***Effects of Creep on Concrete :***

(i) In reinforced concrete beams, creep increases the deflection with time.

(ii) In eccentrically loaded columbns, creep increases the deflection and can load to buckling.

(iii) Creep property of concrete will be useful in all concrete structures to reduce the internal stresses due to non-uniform load or restrained shrinkage.

(iv) In mass concrete structures such as dams, on account of differential temperature conditions at the interior and surface, creep is harmful.

30. Temporary adjustments are these which are made at every instrument setting and preparatory to take observations :

(i) ***Setting over the station :***

The operation of setting up includes centering of the instrument over the station mark by a plumb bob and approximate levelling with help of tripod legs.

(ii) ***Levelling up***

Accurate levelling is done with the help of foot screws and with refrence to the plate leaves.

(iii) ***Focusing / Ellimination of parallax***

Parallax is a condition arising when the image formed by objective is not in the plane of cross hairs. It can be eliminated by focusing the eye-piece and objective.

31. ***The sensitiveness of the bubbles tube can be increased by :***

(i) Increasing the internal radius of the tube.

(ii) Increasing the diameter of tube.

(iii) Increasing the length of bubble.

(iv) Decreasing roughness of walls.

(v) Decreasing the viscosity of the liquid.

32. Thiessen polygon method is only a mechanical and mathematical process and do not required any special skill, but on the contrary isohyetal method requires a let of extra special judgement for drawing the contours.

Thiessen polygon method is inferior to isohyetal method in terms of accuracy and precision. Isohyetal method is the most accurate method, if the complition of contours is best done.

[PART : C]

33. Assume a trial cycle $C_1 = 50$ second

Number of cycles in 15 min $= \frac{900}{50} = 18$

Green time for road 1, allowing an average time headway of 2.5 seconds per vehicle.

$$G_1 = \frac{178 \times 2.5}{18} = 24.7 \text{ sec}$$

Green time for Road 2

$$G_2 = \frac{142 \times 2.5}{18} = 19.7 \text{ secs}$$

Amber times A_1 and A_2 are 3 and 2 seconds (given)

Total cycle length = 24.7 + 19.7 + 3.0 + 2.0 = 49.4

as this is lower than the assumed trial cycle of 50 secondary another lower cycle length may be tried.

Trial (ii) : Assume trial cycle $\Rightarrow C_2 = 40$ second

No of cycles in 15 minutes = $\frac{15 \times 60}{40} = 22.5$ sec

Green time for road (1) $\Rightarrow G_1 = \frac{178 \times 2.5}{22.5} = 19.8$ sec

Green time for Road (2) $\Rightarrow G_2 = \frac{142 \times 2.5}{22.5} = 15.8$ second

Total cycle length = 19.8 + 15.8 + 3.0 + 2.0 = 40.6 seconds

Trial (iii) : Assume trial cycle $\Rightarrow C_3 = 45$ second

Number of cycle in 15 minutes = $\frac{15 \times 60}{45} = 20$ second

Green time for Road (1) $\Rightarrow G_1 = \frac{178 \times 2.5}{20} = 22.25$ sec

Green time for Road (2) $\Rightarrow G_1 = \frac{142 \times 2.5}{20} = 17.75$ sec

Total cycle length $\Rightarrow$ 22.25 + 17.75 + 3 + 2 = 45.0 seconds

Therefore the trial cycle of 45 seconds may be adopted with the following single phase

$G_1 = 22.25$ sec, $G_2 = 17.75$ sec, $A_1 = 3$ sec, $A_2 = 2.0$ sec

34. Given, Diameter D = 10 cm; length L = 40 cm

Length of Ist part $l_1 = 1.0$ cm

Specific gravity $S_1 = 6.0$

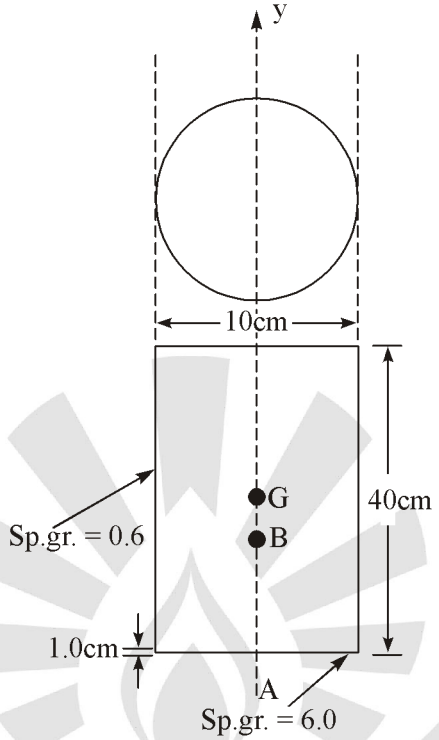
Density of Ist part $\rho_1 = 6 \times 1000 = 6000$ Kg/m^3

Length of II part $l_2 = 40 - 1.0 = 39.0$ cm

Specific gravity $S_2 = 0.6$

Density of IInd part $r_2 = 0.6 \times 1000 = 600$ kg/m^3

The cyclinder will float vertically in water if its metacentric height GM is positive. To find metacentric height, find the location of centre of gravity (G) and Centre of buoyancy (B) of the combined solid cylinder. The distance of the centre of gravity of the solid cylinder from A is given as :



AG = [(Weight of 1st part × distance of C.G. of first part from A) + (Weight of 2nd part of cylinder × distance of C.G. of 2nd part from A)] / (Weight of 1st part + Weight of 2nd part)

$$AG = \frac{\left(\frac{\pi}{4}D^2 \times 1.0 \times 6.0 \times 0.5\right) + \frac{\pi}{4}D^2 \times 39.0 \times 0.6\left(1.0 + \frac{39}{2}\right)}{\left[\left(\frac{\pi}{4}D^2 \times 1.0 \times 6.0\right) + \left(\frac{\pi}{4}D^2 \times 39 \times 0.6\right)\right]}$$

$$AG = 16.42 \text{ cm}$$

To find the centre of buoyancy of the combined two parts or of the cylinder determine the depth of immersion of the cylinder. Let the depth of immersion of the cylinder is h.

Then, weight of cylinder = weight of water displaced

$$\left(\frac{\pi}{4} \times (0.1)^2 \times \frac{39.0}{100} \times 600 \times 9.81\right) + \left(\frac{\pi}{4}(0.1)^2 \frac{1.0}{100} \times 6000 \times 9.81\right)$$

$$= \frac{\pi}{4} \times (0.1)^2 \times \frac{h}{100} \times 1000 \times 9.81 \quad |\because \text{ 'h' is in 'cm'}$$

or cancelling, $\frac{\pi}{4}(0.1)^2 \times \frac{1000 \times 9.81}{100}$

Throughout, we get

$(39.0 \times 0.6) + (1.0 \times 6.0) = h$ or $h = 29.4$

$\therefore$ The distance of the centre of the buoyancy B, of the cylinder from A is

$$AB = \frac{h}{2} = \frac{29.4}{2} = 14.7$$

$$BG = AG - AB = 16.42 - 14.70 = 1.72 \text{ cm}$$

Meta Centric height GM is given by

$$GM = \frac{I}{\forall} - BG$$

Where, I = Moment of inertia of plan of the body about y – y

$$= \frac{\pi}{64}D^4 = \frac{\pi}{64}(10)^4 \text{ cm}^4$$

where, $\forall$ = Volume of cylinder in water.

So, $\Rightarrow \forall = \frac{\pi}{4}D^2H = \frac{\pi}{4}(10)^2 \times 29.4$

$$\Rightarrow \frac{I}{\forall} = \frac{\pi}{64}(10)^4 \Big/ \frac{\pi}{4} \times (10)^2 \times 29.4$$

$$= \frac{1}{16} \times \frac{10^2}{29.4} = \frac{100}{19 \times 29.4} = 0.212$$

$$GM = 0.212 - 1.72 = -1.508 \text{ CM}$$

As GM is negative. It means that the methcenter (M) is below the centre of gravity (G). Thus the cylinder is in unstable equilibrium and so it can not float vertically in water.

35. Given, diameter of large pipe, $D_1 = 150$ mm $= 0.15$ m

Area of large pipe, $A_1 = \frac{\pi}{4}(0.15)^2 = 0.01767 \text{ m}^2$

Diameter of smaller pipe, $D_2 = 100$ mm $= 0.10$ m

Area of smaller pipe $A_2 = \frac{\pi}{4}(0.1)^2 = 0.007854 \text{ m}^2$

Discharge, Q = 30 litre/sec = 0.03 m^3/s

Coefficient of contraction $C_c = 0.6$

From continuity equation, we know $A_1V_1 = A_2V_2 = Q$

$$V_1 = \frac{Q}{A_1} = \frac{0.03}{0.01767} = 1.697 \text{ m/s}$$

$$V_2 = \frac{Q}{A_2} = \frac{0.03}{0.007854} = 3.82 \text{ m/s}$$

Applying bernoulli's equation before and after contraction.

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + h_L \; [\because Z_1 = Z_2]$$

and, h_l, the head loss due to contraction is given by equation

$$h_l = \frac{V_2^2}{2g}\left[\frac{1}{C_c} - 1\right]^2 = \frac{3.82^2}{2 \times 981}\left(\frac{1}{0.6} - 1\right)^2 = 0.33$$

Substituting these values in equation (1), we get

$$\Rightarrow \frac{p_1}{\rho g} + \frac{1.697^2}{2 \times 9.81} = \frac{p_2}{\rho g} + \frac{3.82^2}{2 \times 981} + 0.33$$

$$\Rightarrow \frac{p_1}{\rho g} + 0.1467 = \frac{p_2}{\rho g} + 0.7438 + 0.33$$

$$\Rightarrow \left(\frac{p_1 - p_2}{\rho g}\right) = 0.9271 \text{ m of water}$$

$\Rightarrow (p_1 - p_2) = 0.9271 \; \rho g$

$\Rightarrow (p_1 - p_2) = 0.9271 \times 1000 \times 9.81 \text{ N/m}^2$

$(p_1 - p_2) = 0.909 \text{ N/cm}^2$

$\therefore$ Pressure loss across contraction

$\Rightarrow (p_1 - p_2) = 0.909 \text{ N/cm}^2$

36. On examining the observed bearings of the lines, it will be noticed that difference between back and fore bearings of the line DE is exactly 180°. Hence both stations D and E are free from local attraction and all other bearings measured at these stations are also correct. Thus, the observed bearing of DC (i.e., 209°10') is correct. The correct bearing of CD will therefore, be 209°10' – 180° = 29°10' while the observed bearing is 29°45'. Error at C is therefore

+35' must be applied to all the bearings measured at C. The correct bearings of CB thus becomes 226°10' – 25' = 225°45', and that of AB as 225°45' – 180° = 45°45' which is the same as the observed one. Station A is, therefore, free from local attraction.

Line	Observed Bearing	Correction	Corrected Bearing	Remarks
AB	45°45'	0 at A	45°45'	*Section B and C are Affected by local attraction*
BA	226°10'	–25' at B	225°45'	
BC	96°55'	–25' at B	96°30'	
CB	277°5'	–35' at C	276°30'	
CD	29°45'	–35' at C	29°10'	
DC	209°10'	0 at D	209°10'	
DE	324°48'	0 at D	324°48'	
ED	144°48'	0 at E	144°48'	

37. ***(i) Assumed Data : Letus Assume :***

- Peak flow = 3 times the average flow
- Velocity of flow in rising mains = 1 m/s
- Minimum time of pump running continuously = 15 min
- Head losses in bends etc. = 0.4 m
- Efficiency of pump = 65%
- Efficiency of driving-units = 75%

(ii) Peak Sewage Flow :

$$q_{avg} = 0.8 \times \left[\frac{60000 \times 180}{24 \times 60 \times 60}\right] \times 10^{-3} = 0.1 \text{ Cumec}$$

$$\therefore q_{max} = 0.1 \times 3 = 0.3 \text{ Cumec}$$

(iii) Diameter of rising main → Velocity of flow in rising main 1 m/s

$$\text{Area of cross-section} = \frac{0.3}{1} = 0.3 \text{ m}^2$$

$$\therefore \text{Diameter} \Rightarrow D = \sqrt{\frac{0.3 \times 4}{\pi}} = 0.618 \text{ m} \simeq 61.8 \text{ cm}$$

Provide rising main of 62 cm diameter actual velocity of flow

$$= \frac{0.3}{4/\pi(0.62)^2} = 0.994 \text{ m/sec}$$

(iv) Design of sump well → Sump will be designed for 15 minutes flow

Peak flow rate = 0.3 cumec

∴ Quantity of sewage collected in 15 min

$= 0.3 \times 15 \times 60 = 270 \text{ m}^3$

Quantity of sewage in rising main

$$= \frac{\pi}{4}(0.62)^2 \times 120 = 36.23 \text{ m}^3$$

∴ Total capacity of sump well

$= 270 + 36.23 = 306.23 \text{ m}^3$

Letus provide 3 sumpwells,

two → Storing the sewage

One → Stand by

Let the depth of each unit = 3

∴ Surface area of each unit $= \frac{306.23}{2 \times 3} = 51.04 \text{ m}^2$

Dia of sump well $= \sqrt{\frac{51.04 \times 4}{\pi}} \simeq 8.1 \text{ m}$

Hence, provide 3-units of sump-wells, each of 8.1 diameter and 3 m depth.

(v) Design of Pumps → Each pump has to lift a sewage of

$\frac{306.23}{2} = 153.155 \text{ m}^3$ in 15 minute

∴ Capacity of each pump $= \frac{153.115}{15 \times 60} = 0.170$ Cumec

Let us assume, darcy's friction factor = 0.04

$$h_f = \frac{fLV^2}{2gD} = \frac{0.04 \times 120 \times (0.994)^2}{2 \times 9.81(0.62)} \approx 0.39\text{m}$$

Losses in bends etc = 0.4 m

Total losses $H_L = 0.39 + 0.4 = 0.79$ m

Static lift = 129 – 120 = 9.00 m

Total lift = $H + H_L = 9 + 0.79 = 9.79$ m

$\therefore$ B.H.P of pump mota = $\frac{QwH}{75\eta_p\eta_d}$

$$P = \frac{0.17 \times 1000 \times 9.79}{75 \times 0.65 \times 0.75} = 45.51 \text{ HP}$$

Let , Power = 46 HP

38. When a tree is newly falled, it contains about 50% or more of it's own dry weight as water. This water is in the form of sap and moisture. The water is to be dried. This process of drying of timber is known as the seasoning of timber and the moisture should be extracted during seasoning under controlled condition.

Methods of Seasoning :

(1) Natural Seasoning :

In this method, the seasoning of timber is carried out by natural air and hence it is also sometimes reffered to as air-seasoning.

(a) The timber is cut and sawn into suitable sections of planks or cantlings, and the stacks are placed either horizontally or vertically.

(b) The platform for stacks is made slighty higher say 300 mm and the timber pieces are arranged in layers.

(c) Each layer is separated by sound dry wood.

(d) The width and height of stack are restricted to about 1500 mm and 3000 mm respectively. Distance between layers is kept 25 mm and that between stacks is 450 - 600 mm.

(2) Artificial Seasoning :

Following are reasons for adopting the artificial seasoning :

(a) The defects such as shrinkage, crack, are minimized

(b) The drying is more controlled.

(c) The drying of different surfaces is even and uniform.

Methods of Artifical Seasoning :

(1) Boling

In this method, the timber is immersed in water and water is then boiled. This is a very quick method. The timber is thus boiled with water of about 3 - 4 hours. It is then dried very slowly under a shed.

(2) Chemical Seasoning :

This is also known as the salt-seasoning. In this method, the timber is immersed in a solution of suitable salt. It is then taken out and seasoned in the ordinary way.

(3) Electrical Seasoning :

In this method, the use is made of high frequency alternating currents. The timber, when it is green, offers less as resistance to the flow of electric current.

(4) Kiln-Seasoning :

In this method, the drying of timber is carried out inside an air tight chamber or oven.

(5) Water-Seasoning :

The water seasoning is a quick method and it renders timber which is less liable to shrink or wrap, it also removes organic material content in sap of timber.

39. Design procedure for Lacey's theory is as follow :

(a) Calculation of Velocity

$$V = \left[\frac{Qf^2}{140}\right]^{1/6}$$

Where Q is discharge in cumecs, V is velocity in m/s and f is self factor, it is given by $f = 1.76\sqrt{d_{mm}}$ and d_{mm} is average particle size in mm

Thus, $f = 1.76\sqrt{0.5} = 1.24$

$$V = \left[\frac{5\times(1.24)^2}{140}\right]^{1/6}$$

$\Rightarrow$ $V = 0.616$ m/s

(b) Calculation of Hydraulic mean depth

$$R = \frac{5}{2}\times\frac{V^2}{f} = \frac{5}{2}\times\frac{(0.616)^2}{1.24} = 0.766 \text{ m}$$

(c) Calculation of area of channel section

$$A = \frac{Q}{V} = \frac{5}{0.616} = 8.12 \text{ m}^2$$

(d) Calculation of wetted perimeter

$$P = 4.75\sqrt{Q} = 4.75\sqrt{5} = 10.62 \text{ m}$$

For trapezoidal channel with side slope of $\frac{1}{2}H : 1V$, we get

$$P = B + 2y\sqrt{N^2+1} \text{ and } A = (B + Ny)y$$

$$(B+0.5y)y = 8.12$$

$$B + 2y\sqrt{(0.5)^2+1} = 10.62$$

Solving (1) and (2), we get y = 0.9 m and B = 7.6 m

(e) Calculation of Bed slope

$$S = \frac{f^{5/3}}{3340Q^{1/6}} = \frac{(1.24)^{5/3}}{3340\times(5)^{1/6}} = \frac{1}{3051}$$

❍❍❍